THE EFFECT OF ACUPUNCTURE TREATMENTS ON GAIT OUTCOME MEASURES -A RANDOMIZED DOUBLE BLINDED PLACEBO-CONTROLLED STUDY ON 16 DOGS SUFFERING FROM OSTEOARTHRITIS DUE TO HIP DYSPLASIA

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Licentiate Thesis in Veterinary Medicine
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2016

Tiedekunta - Fakultet - Faculty Eläinlääketieteellinen tiedekunta		Osasto - Avdelning - Department Kliininen hevos- ja pieneläinsairauksien osasto
Tekijä - Författare – Author Teija Pylkäs		
Työn nimi - Arbetets titel – Title The effect of acupuncture treatments on gait outcome measures – a randomized double blinded placebo-controlled study on 16 dogs suffering from osteoarthritis due to hip dysplasia		
Oppiaine - Läroämne – Subject Pieneläinkirurgian oppiaine		
Työn laji - Arbetets art - Level Lisensiaatin tutkielma	Aika - Datum - Month and year 1.3.2016	Sivumäärä - Sidoantal - Number of pages 57

Tiivistelmä - Referat – Abstract

Lonkkadysplasia, eli lonkkanivelen kehityshäriö, on koirien yksi merkittävimpiä ortopedisiä sairauksia. Lonkkadysplasia ja sen seurauksena kehittynyt nivelrikko aiheuttavat koiralle kroonista kipua. Sairaus voi ilmetä muun muassa koiran ontumana, jäykkyytenä ja liikkumishaluttomuutena. Lonkkadysplasian hoitovaihtoehdot vaihtelevat riippuen koiran iästä ja sairauden asteesta. Tyypillisesti lonkkadysplasian hoito perustuu painonhallintaan ja kivun lievitykseen tulehduskipulääkkeitä hyödyntäen. Myös kirurginen hoito voi olla tarpeellinen joillekin yksilöille. Kipulääkkeiden käyttö tai kirurginen hoito ei kuitenkaan sovi kaikille potilaille mahdollisten sivuvaikutusten tai kalliiden kustannusten vuoksi. Tästä johtuen on olemassa tarve löytää muita vaihtoehtoisia hoitomuotoja. Eläinlääketieteessä akupunktio on herättänyt lisääntynyttä kiinnostusta kroonisen kivun lievittäjänä. Vaikka akupunktiota on hyödynnetty jo tuhansien vuosien ajan, on sen käytöstä eläinlääketieteessä vain muutamia tieteellisiä tutkimuksia. Akupunktion etuna pidetään sen pitkäaikaista kipua lievittävää vaikutusta ja vähäisiä sivuvaikutuksia.

Tutkielmaan sisältyvä tutkimus on kaksoissokkoutettu, satunnaistettu, plasebokontrolloitu tutkimus. Tutkimuksessa tutkittiin ohutneula-akupunktion vaikutusta lonkkadysplasiaa sairastavien koirien ontumaan hyödyntämällä askelvoimamittauksesta saatavia kineettisiä ja kinemaattisia mittaustuloksia. Askelvoimamittaukset suoritettiin askelvoimalevyn ja askelvoimamaton avulla ja valittuja askelparametreja olivat maksimaalinen kohtisuora voima, impulssi, raajan maksimaalinen kuormitusnopeus, maksimipaine, kontaktiaika ja tassun kontaktialue. Jokaiselle valitulle muuttujalle laskettiin epäsymmetriaindeksi matemaattista kaavaa hyödyntämällä. Koirien ontuman muutosta arvioitiin vertaamalla koirien alkutilanteen epäsymmetriaindeksejä lopputilanteen indekseihin ja lisäksi akupunktioryhmän ja lumeryhmän tuloksia verrattiin toisiinsa. Hypoteesina oli, että akupunktioryhmään kuuluvien koirien ontuma vähenisi mikä näkyisi askelparametrien epäsymmetriaindeksien laskuna.

Tutkimuksessa oli mukana 16 lonkkadysplasiaa sairastavaa koiraa. Koirat oli jaettu satunnaisesti akupunktio- ja lumeryhmiin siten, että molemmissa ryhmissä oli 8 koiraa. Kaikki koirat kävivät tutkittavina yhteensä viisi kertaa noin viikon välein. Akupunktioryhmän koirat saivat kolmen keskimmäisen käynnin yhteydessä ohutneula-akupunktiohoitoa. Lumeryhmän koirat odottivat eläinlääkärin huoneessa saamatta hoitoa. Käyntien yhteydessä kaikille koirille tehtiin myös subjektiivinen ontumatutkimus, suppea ortopedinen ja neurologinen tutkimus, askelvoimamittaukset ja lisäksi koirista otettiin verinäytteitä. Koirien omistajat täyttivät joka käynnin aikana koiraa koskevan kyselylomakkeen. Koirien ontuman alku- ja lopputasot määritettiin ensimmäisen hoitokäynnin ja viimeisen käynnin perusteella. Tutkimuksen pienen otoskoon vuoksi tilastolliset menetelmissä hyödynnettiin parametrittomia testejä. P-arvon rajaksi asetettiin < 0.05.

Tutkimuksessa ei todettu tilastollisesti merkittävää eroa akupunktio- ja lumeryhmän välillä tai ryhmien sisällä. Akupunktioryhmässä kaikki epäsymmetriaindeksit laskivat kun taas lumeryhmässä kolme epäsymmetriaindeksiä nousi (impulssi, kontaktiaika ja tassun kontaktialue), yksi pysyi samana (maksimipaine) ja kaksi laski (maksimaalinen kohtisuora voima ja maksimaalinen kuormitusnopeus). Vaikka tieteellisesti todistettua näyttöä ohutneula-akupunktion tehosta ei tämän tutkimuksen puitteissa saatu, antavat tulokset viitteitä ohutneula-akupunktion potentiaalisesta myönteisestä vaikutuksesta lonkkaperäisen kivun lievittämisessä. Mahdollisen tilastollisen merkittävyyden esiintuomiseksi tarvitaan lisää tutkimuksia suuremmilla otoksilla.

Avainsanat - Nyckelord – Keywords
Acupuncture, canine hip dysplasia, osteoarthritis, asymmetry index, gait analysis, force plate, pressure sensing walkway

Säilytyspaikka - Förvaringställe - Where deposited
Helda kirjasto

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TABLE OF CONTENTS

1 INTRODUCTION 1
2 LITERATURE REVIEW 2
2.1 Hip dysplasia and osteoarthritis 2
2.1.1 Clinical signs and diagnosis of hip dysplasia 4
2.1.2 Treatment of hip dysplasia 6
2.2 Assessment of chronic pain 9
2.2.1 Subjective evaluation of lameness 10
2.2.2 Objective gait analysis 11
3 MATERIALS AND METHODS 19
3.1 Materials 19
3.2 Methods 22
3.2.1 Study design and protocol 22
3.2.2 Radiography 24
3.2.3 Owner assessment: questionnaires 24
3.2.4 Subjective evaluation of lameness and locomotion of dogs 25
3.2.5 General, orthopedic and neurological examination 25
3.2.6 Gait analysis with force plate and pressure sensing walkway 26
3.2.7 Blood samples 28
3.2.8 Acupuncture and placebo treatment 29
3.2.9 Statistical methods 29
4 RESULTS 31
4.1 Clinical data 31
4.2 Asymmetry indices 32
5 DISCUSSION 37
5.1 Results 37
5.2 Limitations and bias 39
6 ACKNOWLEDGEMENTS 40
8 REFERENCES 41
9 APPENDICES 48

1 INTRODUCTION

Canine hip dysplasia is, undoubtedly, one of the most common developmental disorders affecting the canine population. Even though extensive research has been made and many control programs have been established over the decades, the disease continues to affect high percentages of many different breeds. Canine hip dysplasia is a developmental disorder of the hip joints resulting in secondary osteoarthritis and clinical symptoms such as pain and lameness of different grades. Traditional treatment options include conservative and medical management as well as surgical treatment. Anyway, expensive and invasive surgery or regular use of painkillers that can cause severe side effects to some of the dogs might not be an option to every patient. Therefore, there is an obvious need for wider choice of treatments so that a suitable option could be found for every patient. One alternative treatment that has recently gained attention also in the field of veterinary medicine is acupuncture. Acupuncture has been used for treating chronic pain because it can offer long lasting pain relief without negative side effects. Although the acupuncture technique has been used for thousands of years there are very few studies on its application into veterinary medicine.

This study is a randomized double blinded placebo-controlled clinical trial that deals with the effect of dry needle acupuncture treatment on dogs suffering from hip dysplasia and osteoarthritis. In addition to the study reported here, three other licentiate theses will be done from this clinical trial. The purpose of this study was to see if a dry needle acupuncture treatment has an influence on locomotion of dogs suffering from hip dysplasia and secondary osteoarthritis. Evaluation of the gait of the dogs before and after the treatment was done by using force plate and pressure sensing walkway analysis systems. Asymmetry indices (ASI) that can be used in detecting lameness in dogs were calculated for chosen force plate and pressure sensing walkway system gait variables. Comparisons of asymmetry indices from baseline visit and follow-up visit was done to detect changes in locomotion. The hypothesis was that dogs treated with dry needle acupuncture might show a decrease in lameness which can be seen as a reduction in the asymmetry indices.

2 LITERATURE REVIEW

2.1 Hip dysplasia and osteoarthritis

Hip dysplasia is a common, at least partly inherited developmental disorder affecting the canine population. It is a biomechanical disease where hip instability in the young dog alters the concentration of forces on the growing femoral head and acetabulum (Alexander 1992). This leads to the development of a loose, ill-fitting coxofemoral articulation. In a normal hip joint the stability is assured by the soft tissue links between the pelvis and the femur, such as the round ligament, the joint capsule and the muscles. In addition, the joint capsule with the synovial fluid produces a suction-like stabilizing effect. In a dysplastic hip joint the instability enables a more or less severe dislocation of the femoral head out of the acetabular cup. A complete luxation of the coxofemoral joint is the worst alteration of the disease. An abnormal hip joint conformation results in abnormal wearing of the joint surfaces and invariably leads to secondary degenerative joint disease, osteoarthritis. Usually joint laxity affects both sides, occasionally only one is involved (Brass 1989). There is also evidence, that osteoarthritic changes are not only a problem of the hip region in hip dysplastic dogs, but osteoarthritis also often occurs simultaneously in the shoulder, the stifle and in the vertebral joints and less often in other joints (Kealy et al. 2000, Lust 2010).

Hip dysplasia has a genetic basis but there are also environmental factors that have an effect on the severity of the phenotypic disorder. It is a polygenic quantitative trait caused by the interactions of hundreds of genes. It is also an additive trait where the severity of an individual's disease is determined by the number of affected genes present (Brass 1989). The expression of these genes may be modified by a number of environmental factors that do not cause the disease but alter the manifestation of the trait and its severity (Brass 1989, Alexander 1992, Kealy et al. 1992). The most important environmental factor causing hip dysplasia has been suggested to be energy overfeeding during puppyhood (Kealy et al. 1992, Lust 1997).

Many countries and kennel organisations have had control programs for hip dysplasia for decades. These programs aim to reduce the incidence of hip dysplasia by selective breeding strategies. The true occurrence of canine hip dysplasia is however not known, because a relatively small proportion of the dogs is examined and also because dogs affected by the severe form of hip dysplasia might not be officially screened. Reported breed prevalences vary from 2% to 67% and in general hip dysplasia is particularly prevalent in large and giant breeds of dogs (Krontveit et al. 2010). Common breeds that are prone to hip dysplasia are for example Bernese mountain dogs, German Shepherds, Golden Retrievers, Labrador Retrievers, Newfoundlands, Rottweilers and Samoyed dogs (LaFond et al. 2002). Hip dysplasia is less common in small and miniature breeds, but at the same time these dogs rarely have clinical disease and are therefore much less studied with regard to hip dysplasia (Krontveit et al. 2010). Males and females are affected with equal frequency (Lust 1993).

In Finland a hip dysplasia control program is included in many breeds' breed specific PEVISA program that is accepted by the Finnish Kennel Club. The PEVISA program is a health program that aims to improve genetic health of the dogs and it contains screening of different inherited disorders depending on the breed. If the breed is applying to a PEVISA program and a hip dysplasia control program is included into it, it means that official radiographic evaluation of the hip joints and adequate hip scores are a mandatory prerequisite for all the dogs that will be used in breeding. Dogs must be over one year of age for official screening (Finnish Kennel Club webpage 2016).

According to the Finnish Kennel Club the health of the hip joints in some breeds (i.e. St. Bernard, Rough Collie, Newfoundland, Beauceron and Border collie) has improved during the last decades (Mäki 2014). However, based on the breeding databases of the Finnish Kennel Club, hip dysplasia is still a very common disease among Finnish dogs. These databases reveal for example that out of the Newfoundlands born in Finland during 2008-2013, 33 % were officially screened for hip dysplasia and 52 % of the ones that were screened had hip dysplasia of different degrees (FCI's grading scores from C to E). Equivalent hip dysplasia percentages were 45 % for St. Bernard (screened 38 %), 44 % for Lagotto Romagnolo (screened 51 %), 40 % for Bernese Mountain Dog (screened 51 %), 38 % for Golden Retrievers (screened 43 %), 35 % for German Shepherd (screened 49 %), 32 % for Samoyed Dog (screened 58 %), 25 % for Rottweiler (screened 49 %), 21 % for Rough Collie (screened 42 %) and 20 % for Labrador Retriever (screened 53 %) (Breeding databases of the Finnish Kennel Club 2016).

2.1.1 Clinical signs and diagnosis of hip dysplasia

The diagnosis of hip dysplasia is based on age, breed, history, physical findings and radiographic changes (Schulz 2013). Clinically hip dysplasia varies widely (Brass 1989) and the symptoms depend on the severity of the dysplasia (review by Singh et al. 2007). Nevertheless, sometimes dogs with even severe radiographic signs of hip dysplasia may be asymptomatic when examined clinically (Schulz 2013). In general, there are two ages at which animals present with overt clinical signs of hip dysplasia (Fry and Clark 1992, review by Anderson 2011, Schulz 2013). Dogs younger than 12 months of age have a tendency to have periods of acute bilateral or occasionally unilateral lameness in their pelvic limbs (Fry & Clark 1992, review by Singh et al. 2007). These juvenile dogs are painful and lame because of hip instability that causes stretching of soft tissues and because wear of articular cartilage exposes pain fibers in the subchondral bone. Also the stress caused from weight bearing over a small area in the hip joint brings on acetabular microfractures (Schulz 2013). In older dogs, hip dysplasia causes chronic pain through osteoarthritis (review by Ginja et al. 2010, review by Anderson 2011, Schulz 2013). Typically there is a painless period between these pain episodes and an asymptomatic period may last for months to years (Fry & Clark 1992).

Typical clinical signs in young dogs include difficulty in rising after rest, exercise intolerance, and intermittent or constant lameness. Physical examination findings in young dogs include pain during hip joint extension, external rotation and abduction. Also pelvic musculature is usually poorly developed (Schulz 2013).

Older dogs may develop additional signs that are caused by progressive osteoarthritis (Schulz 2013). These dogs have gait abnormalities such as stiffness, a swaying action of the hips, a narrow based stance, reduced height of step, shortened stride length, bunny hopping, difficulty in rising or lying down and climbing stairs or in jumping over obstacles (Brass 1989, Fry and Clark 1992, review by Ginja et al. 2010, review by Singh et al. 2007). Lameness is particularly seen during walking and trotting, after a period of rest. Pain can also get worse in cold and wet climate (Brass 1989). Older dogs exhibit hind limb lameness with an attempt to transfer weight from rear limbs to the forelimbs (Fry & Clark 1992, review by Singh et al. 2007). Because of this, the pelvic limb muscles develop partial atrophy with compensatory shoulder muscle hypertrophy (Fry & Clark 1992). Furthermore the movement range of the hind legs may be restricted and passive extension of the hind legs often causes pain (Brass 1989).

A thorough clinical examination should include observation of the patient at rest, walking and trotting, and re-examination after heavy exercise. There are a number of clinical tests that give information about the hip joint. Clinical tests that give information on joint laxity (i.e. Ortolani test, Barden test and Barlow's sign) are recommended mainly for use in young animals (Fry & Clark 1992). Clinical test that are used to detect signs of osteoarthritis include palpation and range of motion tests (review by Ginja et al. 2010). With osteoarthritis and capsular fibrosis the range of motion of the coxofemoral joints is decreased (Fry and Clark 1992). In palpation of a hip joint with osteoarthritis crepitus may be detected and pelvic muscle atrophy is a common finding (Schulz 2013). Manipulation of hip joints causes pain especially during extension. The detection of coxofemoral pain can also be aided by putting additional pressure over the dorsum of the pelvis in the standing patient. Usually clinically affected dogs response to the dorsal pressure by sitting down (Fry and Clark 1992).

The clinical diagnosis is confirmed by radiographs. The standard radiographic position involves placing the dog in dorsal recumbency with the hip joints fully extended and the stifles adducted and internally rotated (Schulz 2013). There are three somewhat differing scoring modes for canine hip dysplasia in use internationally: The FCI (Fédération

Cynologique Internationale), The OFA (Orthopedic Foundation for Animals), and the BVA/KC (British Veterinary Association/ The Kennel Club) mode (Flückiger 2007, review by Ginja et al. 2010). In Finland the FCI's grading system is used. The FCI proposes a 5 graded scoring system from A, reflecting the normal hip joint, to E, indicating severe hip dysplasia (Appendix 1). Grades are based on the size of Norberg angle, degree of subluxation, shape and depth of the acetabulum and signs of secondary joint disease (Flückiger 2007). The disease generally first appears when the dogs are between 4 and 12 months old (Alexander 1992, Lust 1997). However, in some dogs the disease is not evident radiographically until they are 24 months old or even older (Lust 1997).

The standard extended view has been criticized because the position tightens the joint capsule, the ligament of the femoral head, and associated muscles thus being able to mask at least partly the actual grade of laxity in young dogs (review by Fries and Remedios 1995, Vezzoni et al. 2005). The stress radiograph technique (Penn Hip) instead, is aimed at detecting susceptibility to hip dysplasia as early as 4 months of age (Schulz 2013). On the stress radiography two views of the hips are taken in the dorsal position. These views are taken with the hips at a neutral flexion/extension angle and distracted by displacing the femoral heads maximally in a lateral position (review by Ginja et al. 2010, Schulz 2013). These views are then used to calculate a distraction index that is used to predict the likelihood of development of osteoarthritis secondary to hip laxity (Schulz 2013). The radiographic studies must be performed under heavy sedation or under anesthesia, which facilitates accurate positioning by relaxation of the skeletal muscles and favors the detection of joint laxity (review by Ginja et al. 2010, Schulz 2013).

2.1.2 Treatment of hip dysplasia

Conservative and medical management of hip dysplasia and also different surgical options are available for both juvenile and mature dogs with hip pain secondary to hip dysplasia. The choice of treatment for canine hip dysplasia depends on the age of the patient, its history and clinical signs, result of physical examination and radiographs, and the owner's expectations (review by Singh et al. 2007, Schulz 2013). The goal of treatment for the juvenile patient is prevention of cartilage damage. Older patients instead, require therapy to alleviate pain related to secondary osteoarthritis (Johnston 1992). The effective treatment of hip dysplasia is problematic, because currently hip dysplasia is generally diagnosed when osteoarthritis is already at an advanced stage. Thus the treatments often aim at alleviating the chronic pain and improving the function of the hip joints (review by Ginja et al. 2010).

Conservative management is divided into short- and long- term phases. Short-term treatment in acute pain includes exercise restriction, nonsteroidal anti-inflammatory drugs (NSAIDs) and physical therapy (treatment with i.e. heat, cold, water, electricity, massage and exercise). Long-term conservative treatment for pain associated with osteoarthritis includes weight management that is the single most important aspect, nutritional supplementation, exercise moderation, physical therapy and NSAID therapy if needed (Schulz 2013). NSAIDs are a popular class of drugs for treatment of osteoarthrits because of their effectiveness for palliating the painful symptoms and their relative ease of administration (Johnston et al. 2008). However, NSAIDs do not prevent the progression of osteoarthritis and these drugs may also induce serious adverse effects (from simple gastritis and vomiting to gastrointestinal perforation and hemorrhage) (Johnston 1992). Because of the possible adverse effects, the prolonged administration of NSAIDs in elderly dogs is not recommended (Henrotin et al. 2005).

There are anyhow some other possible medical options available for the patients that cannot tolerate NSAIDs or for whom they do not provide sufficient pain relief alone. Amantadine that has been used for the treatment of nervous system disorders in humans may provide benefit when administered with other analgesics (Johnston et al. 2008). Lascelles et al. (2008) demonstrated that using a combination of amantadine and NSAID (meloxicam) to dogs with osteoarthritis resulted in better treatment effect than NSAID alone. Also tramadol, that is a commonly used synthetic opiate in veterinary medicine and gabapentin, that is an epilepsy drug that is used for the treatment of neurogenic pain may also be beneficial adjunctive treatments for osteoarthritis. Anyway the research of their efficacy for the treatment of osteoarthritis in dogs is still scarce (Johnston et al. 2008).

The relative new nutritional supplements that are used in the management of osteoarthritis are for example chondroitin sulfate, glucosamine hydrochloride, green-lipped mussel preparations and omega-3 fatty acids (Johnston et al. 2008). The evidence of the effect of nutritional supplements in alleviating pain is still anecdotal. For example chondroitin sulfate and glucosamine hydrochloride, in the pain management associated with osteoarthritis has been somewhat contradictory. A study by McCarthy et al. (2007) showed some positive effect for improving the clinical signs associated with osteoarthritis in dogs whereas Moreau et al. (2003) did not found these positive effects.

Also acupuncture is receiving considerable interest and a great deal of attention in the veterinary medical fields as an alternative treatment for alleviating chronic pain (Mittleman and Gaynor 2000). There are some scientific studies on the efficacy of acupuncture and its applications into veterinary medicine and many conditions such as chronic degenerative joint disease usually respond well to the treatment (Schoen 2001). Acupuncture is the insertion of needles into specific locations of the body, known as acupuncture points, for the treatment or prevention of many different diseases. The most common acupuncture technique is the so called “dry needle” acupuncture, where stainless steel acupuncture needles are introduces into acupuncture points and left in situ for five to 60 minutes (Saarto et al. 2010). Patients with chronic pain benefit from frequent treatments initially and multiple treatments may be required before significant effect is produced (Gaynor 2000).

The therapeutic or analgesic effect of acupuncture cannot be explained by a single mechanism (Gaynor 2000). It induces its effect primarily through the central nervous system, affecting the musculoskeletal, hormonal and cardiovascular system. Acupuncture increases circulation, causes a release of many neurotransmitters and neurohormones, relieves muscle spasms, stimulates nerves, and stimulates the immune system, among many other beneficial effects. How it works depends on the condition being treated and the points used (Schoen 1998). Acupuncture is particularly useful in patients for whom analgesic and anti-inflammatory medications are either ineffective or are producing side effects, and for whom surgical treatment would either not be helpful or would involve risks related to other preexisting conditions (Schoen 2001).

Surgical therapy of young patients requires early diagnosis of hip dysplasia. Surgery is indicated in juvenile patients when there are athletic requirements or the owner wishes to slow the progression of osteoarthritis. The surgical options that may prevent or limit development of hip dysplasia for juvenile dogs are for example juvenile pubic symphysiodesis (JPS) and triple pelvic osteotomy (TPO) (Schulz 2013). In JPS the growth of the pubis is artificially interrupted while the top of the pelvis continues to grow thus rotating the acetabulum out over the femoral head (review by Singh et al. 2007). This procedure has to be performed while there is still growth potential left in the pelvis (review by Singh et al. 2007) and the puppy must be under 20 weeks of age (Schulz 2013). The best candidates for TPO are the immature dogs that have radiographic evidence of mild to moderate hip subluxation, but that do not have osteoarthritic changes in the hip joints yet (Schulz 2013). This treatment is designed to increase the acetabular coverage of the femoral head by rotating the acetabulum into a roof-like position relative to the femoral head (review by Singh et al. 2007).

Surgical options are indicated to older patients when conservative treatment is not effective. The surgical options include for example total hip replacement (THR) and femoral head and neck excision. These techniques are expensive, have risks and there might be serious complications due to surgery, especially in THR (Schulz 2013).

2.2 Assessment of chronic pain

Osteoarthritis is one of the most common causes of chronic pain in dogs (Hielm-Björkman et al. 2011). Pain has been defined as a repulsive sensory and emotional experience that results in learned avoidance and may alter species-specific traits of behavior. When applied to locomotion, this learned avoidance is referred to as lameness that results from pain from stimulation of nociceptors in the abnormal limb. Most animals that show lameness are believed to experience pain and it is also assumed that the extent of lameness is related to the amount of pain (Hudson et al. 2004). However, pain in dogs is sometimes hard to detect accurately (Hielm-Björkman et al. 2003). Quantifying lameness may be difficult clinically even for experienced evaluators because lameness may not be obvious in clinical settings.

Also limitations on physical and verbal communication leave interpretation of signs of pain to the observers (Conzemius et al. 1997).

2.2.1 Subjective evaluation of lameness

Subjective evaluation of lameness is based on the observer's individual assessment of gait. Clinicians may form their opinion on lameness by evaluating for example changes in limb carriage, duration of weight bearing, stride length, and joint range of motion. The subjective assessment of lameness can be described with different types of scales, generally with numerical rating scales (NRS) or visual analogue scales (VAS) (Waxman et al. 2008). NRS are descriptive scales that usually have 4 or 5 descriptive categories with varying clinical signs of lameness from which to choose from. In comparison, the VAS is a continuous scale and it is usually a 100 mm long line with 2 end points labelled with opposite conditions (Quinn et al. 2007). When applying a VAS the observer places a mark on the line corresponding to his or her interpretation of the lameness (Hielm-Björkman et al. 2011).

According to a study by Quinn et al. (2007) the VAS seems to be more sensitive and is perhaps a better tool to assess lameness than the NRS. Though, studies by Quinn et al. (2007) and Waxman et al. (2008) both revealed that subjective scoring scales are more accurate if lameness is severe and neither VAS nor NRS is accurate in rating dogs that are sound to moderately lame. In addition, the lack of agreement between evaluators has been shown in different studies. In a study by Waxman et al. (2008) where lameness was experimentally induced in dogs, individual assessments of lameness differed greatly even between experienced evaluators. Also Quinn et al. (2007) found that agreement of lameness is low between evaluators unless lameness is severe. Even though subjective scoring systems have some weaknesses, they may be useful in clinical and research evaluation of gait where obtaining and maintaining more objective methods are not available (Quinn et al. 2007).

Because chronic pain in dogs is related to variable and often gradual behavioral disturbances and because lameness is not always obvious in clinical settings, gaining owner

-reported detailed information about the activity and behavior of their dogs may be a valuable source of information to clinicians (Wisemann et al. 2001, Hielm-Björkman et al. 2003). Some relatively new studies have showed that validated questionnaires can be reliable and give repeatable results even when used inexperienced observers (i.e Wisemann-Orr et al. 2004, Hielm-Björkman et al. 2009, Walton et al. 2013). One validated and reliability tested and responsiveness tested questionnaire completed by the owners for evaluation of pain in dogs is Helsinki Chronic Pain Index (HCPI). The HCPI questionnaire consists of 11 questions relating to dog's locomotion and behavior and the chronic pain index total score is constructed as the sum of the owner's answers to these questions (Hielm-Björkman et al. 2009). In a study by Hielm-Björkman et al. (2009) the HCPI questionnaire was found to be a valuable tool to detect chronic pain in dogs and the researchers also proposed that this questionnaire could be used as a tool for chronic pain evaluation in which owners evaluate the outcome of treatments of dogs with osteoarthritis.

2.2.2 Objective gait analysis

Computer-assisted gait analysis techniques are considered more objective and more sensitive than a trained observer in evaluating locomotion and detecting lameness (Quinn et al. 2007, Waxman et al. 2008). Computer-assisted gait analysis devices are based on collecting multiple force and spatiotemporal data that are produced while the dog is moving. Kinetic and kinematic techniques are the two main categories of gait analysis. Kinetic gait analysis refers to the measurement of forces acting on the limb during motion, whereas kinematic gait analysis is descriptive, describing the rate and the location of limbs in space (Gordon-Evans 2012).

Normally a healthy dog carries approximately 60 % of its body weight on the forelimbs and 40 % on the hind limbs (Tano et al. 1998). Lame dog instead attempts to unload an injured limb which alters the load distribution among the remaining limbs and results in an irregular gait pattern (Fischer et al. 2013). In a study by Fischer et al. (2013) the compensatory load shifting mechanism was investigated in dogs with induced hind limb lameness. The researchers wanted to examine not only how the hind limb lameness affects the load bearing in affected limb or both hind limbs but also on the forelimbs. Another otherwise similar study but it examined load redistribution mechanism in dogs with induced forelimb lameness was conducted by Abdelhadi et al. (2013). These studies ended up with similar findings that the center of mass consistently shifted to the contralateral body side and to the front in hind limb lameness and to the rear in forelimb lameness. Figure 1 demonstrates the load shifting pattern in a dog with hind limb lameness.

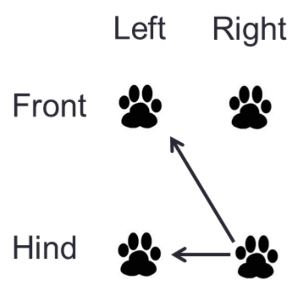

Figure 1. An example of compensatory load redistribution with right hind limb lameness

2.2.2.1 Force plate analysis

Kinetics can be evaluated with computer assisted force plates (Anderson & Mann 1994). This kinetic tool is generally accepted as an objective means of assessment of limb function in dogs (Waxman et al. 2008, Quinn et al. 2007) and it has been widely used in many different studies in measuring the response to treatments of dogs with osteoarthritis due to hip dysplasia, cranial cruciate ligament rupture, elbow dysplasia and many other orthopedic conditions (i.e. Vasseur et al. 1995, Budsberg et al. 1996, 1999a, 2001, Jevens et al. 1996, Tano et al. 1998, Theyse et al. 2000, Kapatkin et al. 2006, van der Peijl et al. 2012).

The force plate analysis is based on the assumption that a lame dog attempts to put less weight on an injured limb (Hudson et al. 2004). The force plate is a surface that is embedded into a walkway and it measures the ground reaction forces created by a dog's limb on the ground during ambulation in three planes: vertical, mediolateral and craniocaudal (Anderson & Mann 1994) from which the vertical forces have turned out to be the most useful forces in gait analysis studies (Budsberg et al. 1996, Budsberg 2001, Fanchon & Grandjean 2007). The variables that are most commonly used in measuring the degree of lameness are peak vertical force and vertical impulse (McLaughlin et al 1991, Quinn et al. 2007). In addition to peak vertical force and vertical impulse, slope data, that represents the loading and unloading rate of a limb, has been used at least in some studies in discriminating between lame and sound dogs (i.e. Evans et al. 2005, Fanchon & Grandjean 2007).

In a force plate analysis the ground reaction forces are evaluated one side at a time which means that in one pass over the force plate the forces caused by the ipsilateral pair of limbs touching the plate are recorded. The peak vertical force that is the most consistent variable in gait analysis illustrates the maximum force applied perpendicular to the surface at the time the foot is in contact with the ground. The vertical impulse instead, describes the total force applied during this stance phase (Gordon-Evans 2012). The peak vertical force and vertical impulse tend to decrease when lameness is present (i.e. Budsberg 2001, Evans et al. 2005, Fanchon and Grandjean 2007). This was demonstrated in a study by Budsberg et al. (2001) in which the cranial cruciate ligament of the knee in laboratory dogs was cut to induce osteoarthritis. The peak vertical force and impulse decreased significantly in the affected hind limb. Also Bennett and al. (1996) compared ground reaction forces of clinically sound dogs and dogs with hip dysplasia. The researchers found significantly lower peak vertical forces in affected dogs when compared to the group of healthy dogs. In their study impulse was the same for both groups. Also studies on treatment response in dogs with hip dysplasia have been conducted. For example the effect of unilateral total hip replacement on lameness has been investigated by Budsberg et al. (1996). They found significant increase in the peak vertical force and in the vertical impulse after recovery time of the treated limb when compared to preoperative values, suggesting positive treatment response.

Slope data includes the rising and falling slope of a limb. The rising slope represents the rate at which a dog loads the limb and the falling slope the rate at which a dog unloads the limb (Evans et al. 2005). Studies that have investigated loading times of a limb have demonstrated that lameness typically causes a decrease in rising slope and an increase in falling slope indicating slow loading and rapid offloading of an affected limb (ie. Evans et al. 2005, Fanchon and Grandjean 2007). These aforementioned studies have indicated that by using a combination of ground reaction forces yields to the better accuracy in assessing lameness than using a single variable alone (Evans et al 2005, Fanchon and Grandjean 2007). A study by Evans et al (2005) found that a combination of the peak vertical force and the falling slope discriminated lame and sound Labrador retrievers much more accurately than did peak vertical force, vertical impulse or falling slope individually. In their study the combination of the peak vertical force and the falling slope yielded a 98% accuracy in determining lameness. A study by Fanchon and Grandjean (2007) found that combining the peak vertical force with the rising slope generated 95 % accuracy in discriminating lame from normal whereas the accuracy was 92% when measuring only the peak vertical force alone.

Even though force plate gait analysis is generally regarded as a reliable method of characterizing ground reaction forces during locomotion, the collection of kinetic data must be carefully controlled because several factors are known to affect ground reaction forces (Beraud et al. 2010). Especially subject velocity and acceleration should be kept constant when performing gait analysis because peak vertical forces increase as subject velocity increases and impulses decrease as velocity increases (Jevens et al. 1996, Budsberg et al. 1999b, Evans et al. 2003, Kennedy et al. 2003, Kim et al. 2011). Trotting velocities of 1,5 m/s to 2,3 m/s (Allen et al. 1994, Bennett et al. 1996, Budsberg et al. 1996, 1999a,b, Jevens et al. 1996) and acceleration variation of ± 0,5 m/s^2 (Budsberg et al. 1996, 1999a) have been used in most force plate studies. Clinical studies have used both walking and trotting gaits in evaluating treatment effects (Evans et al. 2003). Voss et al. 2007 demonstrated in their study that the chosen gait mattered to the accuracy of force plate gait analysis in dogs with low-grade hind limb lameness. In their study they found that trotting gait was more sensitive and accurate than the walking gait for the determination of dogs with low-grade hind limb lameness, and of normal dogs. For dogs that are suffering from severe lameness walking gait may anyhow be preferable, because these dogs can be too lame to use the painful leg at a trot (Evans et al. 2003, Voss et al. 2007). To limit variation ground reaction forces should also be presented as a percentage of body weight (Budsberg et al. 1987, Kim et al. 2011).

There are also several disadvantages when measuring ground reaction forces using one single force plate. The major disadvantage of the kinetic forms of force plate is the inability to measure successive events during locomotion (Anderson & Mann 1994, Lascelles et al. 2006). Some researchers have tried to use multiple force plates to overcome this limitation (i.e. Bertram et al. 1997, Kennedy et al. 2003). Also most force plates are extremely small and multiple passes may be required to collect a representative sample of data (Anderson & Mann 1994, Lascelles et al. 2006). The impact of exercise on gait analysis in dogs with hind limb lameness secondary to osteoarthritis has been studied by Beraud et al. (2010). These researchers demonstrated that even moderate exercise immediately before the gait analysis may cause significant deterioration of limb function and it can cause bias to the values gathered from the force plate (Beraud et al. 2010).

Moreover stride length limitations make it challenging to collect data in small dogs that have typically shorter stride lengths. Additionally force plates do not assess the distribution of force across the foot and cannot be used to evaluate static force distribution at the same time across all four limbs (Lascelles et al. 2006). Because of these limitations, force plates are often used in combination with kinematic forms of gait analysis (Anderson & Mann 1994). According to Lascelles et al. (2006) using this multivariate approach to lameness evaluation decreases the number of recordings and reduces the variability of results.

2.2.2.2 Pressure sensing walkway systems

One type of gait analysis equipment that enables measuring partly both kinetic and kinematic data is pressure sensing walkway system. Unlike force plates, these systems have multiple small pressure sensors encapsulated in walkways. The pressure sensors act in an on or off fashion where vertical pressure exerted by an object causes activation (Gordon-Evans 2012). These multiple sensors improves the ability to collect data for a number of foot strikes for all limbs during a single pass over the walkway, data of actual limb velocity, data from dogs of different sizes, data from individual footfalls even if several feet are on the ground at the same time, and static weight distribution across all limbs in a standing dog (Lascelles et al. 2006). Collecting data from left and right limbs in one trial improves the accuracy of data with regard to detecting asymmetry or evaluating compensation for lameness (Gordon-Evans 2012).

Pressure sensing walkways cannot measure horizontal forces (craniocaudal and mediolateral), but these devices enable recording kinematic spatiotemporal variables such as velocity, stance time, swing time, stride time and stride length. Stance time is the time the paw remains in contact with the ground while swing time is the time the paw remains in the air during a gait cycle. Stride time is the sum of swing time and stance time. Stride time can also be defined as the length of time needed to travel one stride length. Stride length is defined as the distance from one footfall to the next footfall of the same limb (Gordon-Evans 2012). The pressure sensing walkways differ slightly in what they record between manufacturers. In dogs the most used gait analyzing pressure sensing walkways are GAITRite® (GAITRite, CIR Systems Inc., Havertown, PA) and Tekscan (Tekscan Inc, South Boston, MA, USA), which are both originally developed for the human medical field. GAITRite can be used in animals when connected to the GAITFour® software program. The GAITRite walkway system cannot measure kinetic parameters but it records temporal-spatial variables, which include stride length, stride time, stance time, stance time percentage, total pressure index applied by each limb, and number of sensors activated by each paw strike. The number of sensors activated at a time corresponds to the surface of the stance (Light et al. 2010). Tekscan instead was developed to measure vertical ground reaction forces and it records also temporal and distance parameters (Besancon et al. 2003).

Changes in temporospatial variables have been examined in clinically lame dogs by using pressure sensing walkways. In a study by Maitre et al. (2007) the gait of healthy dogs were compared to dogs with cranial cruciate ligament rupture with GAITRite walkway. They discovered that the injured limb of the lame dogs presented a reduced peak pressure and a reduced number of activated sensors compared to healthy dogs. Also the stance of the injured limb was shorter, weaker and smaller. Another study by Gordon-Evans et al. (2009) that examined spatiotemporal gait parameters with both GAITRite and Tekscan walkways in normal dogs and in dogs with spinal cord disease found that dogs with T3-L3 myelopathies had decreased stride time, stance time, and stride lengths in the forelimbs and increased swing-time in the hind limbs. Bennett et al. (1996) conducted a study that used both kinematic video-based gait analysis and force plate data to define alterations of movement in dogs with hip dysplasia. They noticed that stride length was increased and peak vertical force decreased for dogs with hip dysplasia when compared with unaffected dogs while no significant differences were found in subject velocity, stride frequency, or maximal foot velocity between the study groups. The researchers thought that increased stride length with dogs with hip dysplasia might reflect the greater variation in subject velocity but could also represent compensation for decreased hind limb weight-bearing in the dogs with hip dysplasia (Bennett et al. 1996). Although this study did not include pressure sensing walkway but a video-based motion capture system, the gait information gained from the system should be comparable to pressure sensing walkways. The comparability of temporospatial information derived from a pressure sensing walkway and video-based motion capture system was demonstrated in a study by Stokic et al. (2009) in which they studied healthy and chronic stroke human subjects.

There have also been studies that have investigated differences in the data obtained from some force plates and a pressure sensing walkway (Tekscan). In a study by Besancon et al. (2003) a high correlation in vertical impulse between a single force plate and a pressure sensing walkway was found when using normal dogs. Statistically significant differences were noted in peak vertical force values between the two systems. Also Lascelles et al. (2006) compared the data gathered from a pressure sensing walkway and a force plate in clinically normal dogs. They found that ground reaction forces were significantly lower when measured by the pressure sensing walkway. Even though the results obtained from force plate and pressure sensing walkways were not interchangeable, the data derived by use of pressure sensing walkway were consistent and reliable (Lascelles et al. 2006). Some reasons such as calibration techniques, type of sensors, and sampling frequency have been suggested to explain the differences in the vertical force values between the systems (Besancon et al. 2003).

2.2.2.3 Asymmetry indices in distinguishing lameness

Some studies have also investigated symmetry or asymmetry of a gait to identify whether a dog is clinically lame or sound. Usually symmetry refers to comparing a limb to its counterpart rather than comparing front and hind limbs. This is mainly due to the natural difference in weight bearing between front and hind limbs in dogs (Gordon-Evans 2012). Asymmetries in gait have been examined by using asymmetry indices that are calculated from any of the different gait parameters. Some slightly divergent mathematical formulas have been presented for an asymmetry index. One utilized equation for asymmetry indices of ground reaction forces used by Fanchon and Grandjean (2007) is the following: Asymmetry index (ASI) = $(|X_R - X_L|/[|X_R + X_L| \text{ x } 0,5]) \text{ x } 100\%$, where X_R= mean of a given gait variable for right footfalls and X_L= mean of a given gait variable for left footfalls. Using this asymmetry index, the value of 0 indicates perfect gait symmetry.

Using asymmetry indices in gait analysis studies rests on the assumption that the trot of a sound dog is right to left symmetrical (i.e Budsberg et al. 1993, Schaefer et al. 1998, Gillette & Zebas 1999) and an asymmetry in ground reaction forces indicates that load distribution is not symmetrical between the two sides. However, many studies have revealed that not even non-lame dogs had absolutely perfect symmetry during a trotting gait (i.e. Budsberg et al. 1993, Fanchon and Grandjean 2007, Oosterlinck et al. 2011). In a study by Budsberg et al. (1993) the symmetry indices in healthy dogs were evaluated by measuring ground reaction forces with a single force plate. In this study the symmetry indices were calculated using three different methods and all the different asymmetry indices deviated under 8 % from perfect symmetry for all kinetic variables in non-lame dogs. In a study by Fanchon and Grandjean (2007) that examined the accuracy of asymmetry indices of ground reaction forces for diagnosis of hind limb lameness, the cutoff value of the asymmetry index of peak vertical force in discriminating between lame and non-lame dogs was under 3,2 %. Similar findings were revealed in an additional study that dealt with the accuracy of pressure sensing walkway kinetic asymmetry indices for diagnosis of unilateral hind limb lameness in dogs conducted by Oosterlinck et al. (2011). In their study cutoff values of 2 % for the asymmetry index of the paw contact area and between 3 % and 4 % for the asymmetry indices of the peak vertical force and vertical impulse were determined.

Budsberg et al. (1993) found an important limitation in evaluating asymmetry indices with using a single force plate. In their study collecting nonconsecutive footfall data caused right-left limb variation that was attributable from of trial variation, not limb-to-limb variation. Instead, in the study by Fanchon and Grandjean (2007) the data of healthy and lame dogs was recorded on a treadmill with embedded force plates that made simultaneous analysis of consecutive strides possible. Fanchon and Grandjean (2007) found that vertical force variables and especially peak vertical force asymmetry indices had high diagnostic accuracy in the diagnosis of hind limb lameness. Also Budsberg et al. (1993) had found in their study that vertical ground reaction forces provided the most consistent symmetry indices. Besides, Fanchon and Grandjean (2007) found that a multivariate approach that used peak vertical force and maximal rising slope yielded the optimum combination to distinguish between healthy and affected dogs. Oosterlinck et al. (2011) found that sensitivity and specificity for asymmetry indices determined via pressure sensing walkway to discriminate between lame and non-lame dogs were excellent for peak vertical force, vertical impulse and also for paw contact area. They also found that the asymmetry index of peak vertical pressure was not a reliable indicator of clinical lameness in dogs.

3 MATERIALS AND METHODS

3.1 Materials

The suitable dogs for the study were found through advertising that began about one month before the experimental trial took place. The study was advertised on the webpage of the Faculty of Veterinary Medicine, on breed specific internet forums, in a major newspaper Helsingin Sanomat, on notice boards of local veterinary clinics, grocery stores and pet shops and also in various dog parks in Helsinki and regions nearby. In the advertisements the owners of the dogs were informed to apply to the study by filling out a questionnaire on the internet. The questionnaire contained questions about basic information such as breed, age, sex, bodyweight, questions about possible diagnosis from hip radiographs, other concurrent problems, and about typical chronic pain signs such as difficulty in lying down or in getting up from a lying position, difficulty in jumping or totally refusing to jump, difficulty in walking up or down stairs, and lameness in one or both hind legs. The dog's treatment history was carefully inquired and in addition the validated Helsinki Chronic Pain Index (HCPI) - pain questionnaire was integrated into the application form. The owners also had to assess their dog's locomotion difficulties and quality of life by using a visual analogue scale (VAS) that was included into the form.

Acceptance to the study was based on the owners' answers of the application form and the results of a screening visit to which potential patient dogs were invited. Out of 88 applications 22 privately owned dogs were invited to the screening visit and finally 19 dogs were accepted to the study.

For being included in the study the dog had to have a radiographic diagnosis of either moderate (FCI HD classification D) or severe (FCI HD classification E) unilateral or bilateral hip dysplasia and radiographic evidence of osteoarthritis in hip joint. The accepted dogs were not allowed to have any other major problems like heavy lameness from a joint other than the hip and no prior orthopedic surgery. Also the owners had to have marked at least three signs of typical chronic pain symptoms into the application form and the symptoms had to have lasted for more than three months. Other inclusion criteria were a HCPI over 8, weight over 18 kg and the dog should not have had Na-pentosan polysulphate (Carthrophen vet, Arthropharm (Europe) Ltd.) treatment within three months or acupuncture treatment nor any related treatments like gold implants ever before.

The 19 dogs that were included into the study were privately owned pet dogs of different breeds, ages and bodyweights and of both sexes. The dogs belonged to 8 different breeds and one dog was cross-bred. Of the dogs in the study 68,4 percent were female. Their average age was 7 years (range 2 to 13 years) and their average bodyweight was 32,1 kg (range 18,8 to 55,4 kg). The more precise patient descriptive is seen in tables 1 and 2 and in figure 2.

Table 1. Breeds of the dogs in the study

BREED	NUMBER OF DOGS
Cross-bred	1
Doberman Pinscher	1
Flatcoated Retriever	1
German Shepherd	4
Labrador Retriever	7
Lagotto Romagnolo	1
Rottweiler	1
Rough Collie	1
Samoyed Dog	2

Table 2. Classification of hip dysplasia among the dogs

CLASSIFICATION OF HIP DYSPLASIA	NUMBER OF DOGS
A/D	1
D/D	7
A/E	1
E/D	3
E/E	7

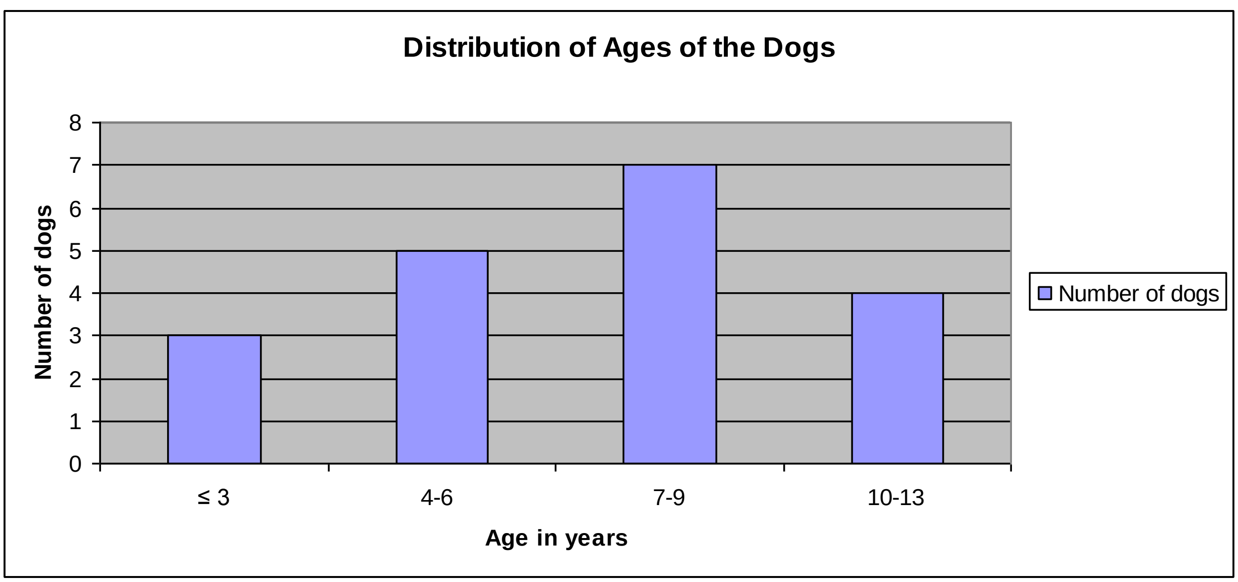

Figure 2. Distribution of ages of the dogs

The sample type represented a convenience sample because the study population consisted of dogs whose owners had volunteered to take part in the study.

3.2 Methods

3.2.1 Study design and protocol

The study was designed as a randomized double-controlled, double-blind clinical trial with a treatment (=acupuncture) group and a negative (=placebo) control group. The clinical trial was conducted at the Small Animal Hospital of the University of Helsinki by three students with a Bachelor of Veterinary Science degree and by one veterinarian. All the researchers and the vet were blinded as were the owners of the dogs. The acupuncture treatment was given by two experienced veterinarians by whom one was certified by the International Veterinary Acupuncture Society (IVAS) and the other only had a long history of giving acupuncture.

The dogs that were included in the study had altogether five visits at the clinic with approximately weekly intervals. The first visit, that took place about one week before the actual study started (week -1 = W_{-1}), was a screening visit in which the dogs were either included or excluded into the study. During this visit blood samples were taken to check basic hematological values and if the dog did not have available radiographs of the hips they were taken during this visit. The dogs were excluded from the trial if either blood values or radiographs showed that they were not suitable for the study. The next 3 visits ($W_{0,}$ W_1 and W_2) were treatment visits from which the W_0 was the baseline for the study. At the last follow-up visit (W_3), the last evaluation was done, but no treatment was given during this visit. Figure 3 shows the timeline of the study visits.

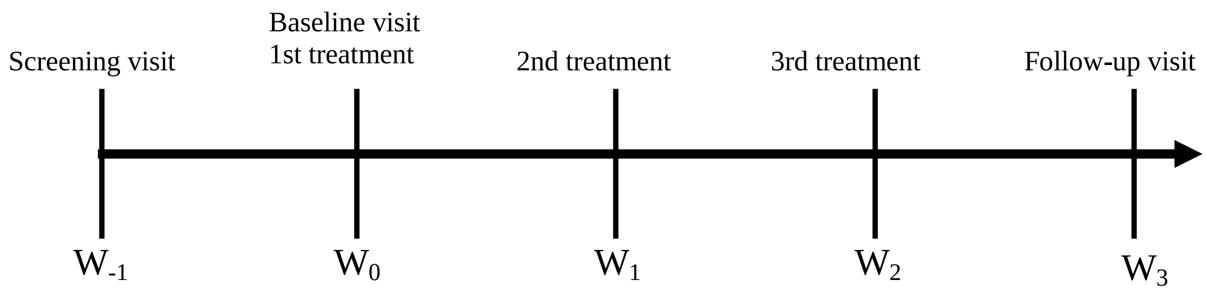

Figure 3. Timeline of study visits. W_{-1}= Week -1; one week before baseline, W_0=baseline and the first treatment visit, W_1 and W_2 = the second and the third treatment visits, W_3 = follow-up visit.

The owners were told not to give NSAIDs or other analgesics one week before the baseline visit and during the whole study. They were also informed not to give any extra nutraceuticals like omega 3 eicosapentaenoic acids or fish oils. For ethical reasons all owners were anyhow given analgesic medication (meloxicam, Metacam®), that they could use if the dog was in considerable pain during the trial. Throughout the trial the owners had to fill in a diary where they reported the possible use of the extra analgesic supplied and the changes in the dog's daily routines such as increased or decreased physical activity. At the first visit the owners of the dogs also had to sign a consent form in which they committed to comply with the instructions of the study. The study protocol was approved by the Ethics Committee of the University of Helsinki.

On every visit the study protocol was almost the same. Actions taken during every visit were done in the same order and they are shown in table 3. Every action is discussed more precisely under its own heading.

Table 3. Actions and their occurrences during the visits. W_{-1}= Week -1; one week before baseline, W_0=baseline, the first treatment visit, W_1 and W_2 = the second and the third treatment visits, W_3 = follow-up visit. 0= action not taken, 1= action taken once, 2 = action taken twice.

Procedure	W_{-1}	W_0	W_1	W_2	W_3
1. Owner assessment (questionnaires)	1	1	1	1	1
2. Subjective evaluation of lameness	1	1	1	1	1
3. General, orthopedic and neurological examination	1	1	1	1	1
4. Force plate and pressure sensing walkway	1	1	1	0	1
5. Blood sample	1	1	0	2	1
6. Acupuncture / placebo treatment	0	1	1	1	0

3.2.2 Radiography

The radiographs of the hips were taken at the end of the screening visit (W_{-1}) from those dogs that did not have hip radiographs already. The radiographs were taken to ensure that the dogs really had hip dysplasia and osteoarthritis on hip joints.

The radiographs were taken under sedation and in a ventrodorsal position. One radiologist diagnosed all the radiographs (whether taken at the screening visit or earlier) by using the 5 grade scoring system from A, reflecting a normal hip joint, to E, indicating severe hip dysplasia. The radiologist also assessed the level of osteoarthritic changes and other possible findings.

3.2.3 Owner assessment: questionnaires

On every visit the owners answered a multidimensional questionnaire while the dog was being tested, evaluated and treated. The questionnaire contained 19 questions dealing with dog's current attitude, behavior and locomotion, using numerical rating scale of 1-5 and a visual analogue scale for both locomotion difficulties and quality of life. There were also some questions about dog's general welfare and medication. These same questions dealing with the dog's general condition were asked on every visit. On visits W_1, W_2 and W_3 the questionnaire also contained 28 comparative questions that dealt with dog's locomotion, every-day situations and skin and coat health. In this part of the questionnaire the owners had to compare the dog's condition to the condition it had before the beginning of the trial. These questions all used 5-point scales (1 = much better, 2 = somewhat better, 3 = the same, 4 = somewhat worse, 5 = much worse). In addition there were some extra questions in the questionnaire on the last visit (W_3). These extra questions were asked to find out to which group they thought their dog belonged to (1 = treatment group, 2= placebo group), their satisfaction to the dog's response to the treatment (1 = very satisfied, 2 = somewhat satisfied, 3 = don't know/ no opinion, 4 = dissatisfied, 5 = very dissatisfied) and how well the response to the treatment corresponded to their expectations of a good treatment (1 = corresponded fully, 2 = quite well, 3 = to some parts, 4 = not so well, 5 = not at all). The owners were emphasized that the same person had to complete the questionnaires every time so that the answers from different visits would be comparable. The last questionnaire is attached as an appendix (Appendix 2).

3.2.4 Subjective evaluation of lameness and locomotion of dogs

The subjective evaluation of lameness and locomotion of dogs was done outside on a concrete surface at the beginning of every visit. The process was filmed every time. The members of the research team observed the dog first trotting and then walking on a leash on a triangular area each side being about 10 meters long. The dogs went two rounds per gait; one for both directions and the researchers made a mark on the protocol paper that best represented the gait of the dog. The severity of lameness was scored from 0 to 5 (0=clinically sound/ no signs of lameness, 1: showing some signs of stiffness, a bit abnormal movement, a bit reluctant to move, 2: obviously stiff, clearly abnormal movement, clearly reluctant to move, 3: heavy/severe lameness, 4: totally lame, does not put weight to the sore leg at all and 5: dog does not obey) and both the walk and the trot were given their own scores.

3.2.5 General, orthopedic and neurological examination

General, orthopedic and neurological examinations were performed on every visit. The purpose of these examinations was to evaluate other possible causes of lameness and assess whether hip dysplasia and osteoarthritis had caused secondary problems. In the general examination the dogs were weighted, a heart auscultation was done and heart frequency was measured. At the baseline visit (W_0) the dogs' body condition scores were also assessed by using a scale from 1 to 5 (1: serious underweight, 2: mild underweight 3: normal weight, 4: mild overweight and 5= serious overweight/obese).

A minor orthopedic examination was done without sedation and it consisted of palpation of the joints of the spine, hips, knees, hocks, fabellas and the digits. The effusion, tenderness and crepitation of these joints were assessed by the researchers.

In the neurological examination the proprioception and the flexion reflex was examined on both sides. The scale used in these examinations was "normal", "a bit slow" and "slow". Pain of the hips was assessed by stretching both hind legs backwards one leg at a time. The researchers observed the range whether the leg bent only downwards or also upwards and if the dog showed signs of soreness when extending the leg. All findings were reported on a protocol sheet.

3.2.6 Gait analysis with force plate and pressure sensing walkway

Gait analysis was carried out with gait analyzing devices, force plate (Kistler force platform, model 9286, Kistler Instrumente AG, Winterhur, Switzerland) and pressure sensing walkway (GAITRite® platinum version, CIR Systems Inc, Havertown, Pa) that were connected to computer-based software programs (Aquire 7.3, Sharon Software Inc., Dewitt, MI and GAITFour®, version 40f, CIR systems Inc, Havertown, Pa respectively). Also a video camera (GAITVideo) was included in the walkway system. Gait analysis was performed on every visit except for the fourth (W_2) visit. On the first visit (W_{-1}) the dogs were guided to run a couple of times over the force plate and the pressure sensing walkway in order to customize them to these gait measuring systems. The gait analysis was left out from the fourth visit (W_2) in order to get one acupuncture/ placebo treatment without a possible stress factor from gait analysis.

The force plate and the pressure sensing walkway were placed in a row to the right side of a 14 meter long corridor. The force plate was recessed into the concrete floor so that vertically there was no difference between the surface of the force plate and the floor. The size of the force plate was 0,60 × 0,40 meter. The force plate was placed lengthwise into the floor, but it was rotated shortside wise for one dog whose step length was too short. Two 1,25 meter long and 4 millimeters thick rubber mats (same material as in the pressure sensing walkway) were placed one before and one after the force plate so that approximately 1 cm gap was left between the mats and the force plate. If it turned out that the dog had problems hitting to the force plate correctly, the first rubber mat was moved a bit backwards. Immediately after the latter rubber mat there was the 5,74 meter long and 0,90 meter wide pressure sensing walkway. The active dimensions of the pressure sensing walkway were 4,86 × 0,9 m. At each end of the walkway there was a short (0,42×0,9 m in the beginning and 0,46 × 0,9 in the end) section of inactive walkway to provide a transition surface when entering and exiting the system. Altogether the whole walkway consisting of two rubber mats, the force plate and the pressure sensing walkway, was nearly 9 meter long. On both sides of the force plate there were railings to guide the dog to step in the right place. On the railings there were also three photoelectric cells placed exactly at a one meter distance from each other determining velocities and accelerations of the dogs. These photoelectric cells and force plate were connected to the same computer which also had the data acquisition software. The recording video camera was placed so that the whole walkway was filmed.

Before starting the analysis the legs of the dogs were color-coded with short pieces of self-adhesive bandages to help recognize which paws hit the force plate. Different colors were used for right and left sides. Dogs were always guided in the same direction over the whole walkway by the owner or a member of the research team. At least two members of the research team observed which feet touched the force plate and this was manually recorded into the computer. The trial was considered valid if a forepaw and then after a short pause, the hind paw of the same side contacted the force plate completely while the dog was trotting next to the handler without pulling on the leash.

Also, for each dog the trotting speed had to be in the same range (± 0.5 m/s) each time the test was performed (at W_{-1}, W_0, W_1, W_3) and acceleration had to be from - 0.5 to + 0.5 m/s² on a valid evaluation. The trial was discarded if the dog was distracted during the measurement, if the limb struck the edge of the force plate, or if any portion of the contralateral paw hit the force plate. At least five visually successful evaluations from the force plate were collected for both the left and right limbs during the visits. On a valid trial on the pressure sensing walkway the dog had to trot in the middle of the walkway with acceptable speed and acceleration and without winding too much. Also at least five visually successful evaluations from the pressure sensing walkway were collected during the visits.

After visual examination of consistent trials, two to five valid measurements from the force plate for each side and one from the pressure sensing walkway for each visit were then chosen by one of the blinded researchers. The measurements were chosen according to valid speed and acceleration, and additionally the dogs were not allowed to have any distracting body movements.

The data obtained with the force plate were averaged. Asymmetry indices were calculated from mean peak vertical force, mean vertical impulses as well as from mean maximum rising slope. The data collected with the pressure sensing walkway were mean stance time, mean total pressure index and mean number of sensors activated. Asymmetry indices were calculated for each of these variables.

The study was based on comparison between the values of asymmetry indices from baseline visit (W_0) and follow-up visit (W_3) and between dogs from the acupuncture group and the placebo group.

3.2.7 Blood samples

Blood samples were collected from the dogs at each visit except from the third visit (W_1). The reason why the blood sample was not taken on the third visit was to have one acupuncture/ placebo treatment that would not be affected by possible stress from collecting blood. Blood samples were always taken after the gait analysis. This was done in that order so that drawing blood would not have any effect on dogs' movements on the walkway. On the fourth (W_2) visit blood samples were exceptionally taken twice, first about half an hour before the acupuncture or placebo treatment and the second sample was collected straight after the treatment. This time blood was taken through an intravenous cephalic catheter, whereas on the other visits blood was taken from the cephalic vein using an open technique with a needle and the test tubes. Because of collecting blood samples, the owners had to fast their dogs for 8 hours before all visits.

3.2.8 Acupuncture and placebo treatment

Dry needle acupuncture or placebo treatment were given on the second, third and fourth (W_0, W_1 and W_2) visits. At the end of these visits each dog was taken to the treatment room where the acupuncture group received acupuncture dry needle treatment whereas the placebo group just came into the same room, but did not receive any treatment. The acupuncture treatment was given by one of the two acupuncture specialists involved in the study and the treatment took about an hour. The bilaterally used acupuncture points were BL_{11}, BL_{54}, BL_{60}, GB_{29}, GB_{30}, ST_{36}, a point close to TH_{12} (the triceps trigger point) and a unilateral point called Bai Hui in the lumbosacral space. Both of the two acupuncture specialist used these same precisely defined acupuncture points every time. The sizes of the needles were 0,25mm x 30 mm. Neither the owner, nor the evaluating researchers were in the room with the dog at the time of acupuncture or placebo treatment.

3.2.9 Statistical methods

This thesis deals only with the research results from the force plate and pressure sensing walkway. The research results from the questionnaires and blood samples are discussed in two other licentiate theses.

The number of dogs needed in each group was calculated by using power analysis with a level of confidence of 95 %, a power of 80 % and the outcomes of gait analysis from a study by Collard et al. 2010 suggesting 17 dogs per groups. In this study the number of dogs was 19, which alone would not be an acceptable sample size and would therefore not necessarily be able to show differences between groups.

The dogs were assigned into the acupuncture or placebo groups in order of arrival using a computer-generated 4 block random list. A high (over 16) or low (16 or lower) level of pain according to the Helsinki chronic pain index (HCPI) and high (weekly) or low (less than weekly) usage of painkillers before the study were used to stratify the dogs into the groups. From each of these strata, dogs were divided evenly between acupuncture group and placebo group by the computer. This stratified randomization by HCPI and usage of painkillers ensured that the acupuncture group and placebo group were as identical as possible. Table 4 presents the distribution of dogs according to the stratification criteria.

Table 4. Distribution of dogs according to the stratification criteria

STRATIFICATION GROUP	ACUPUNCTURE GROUP	PLACEBO GROUP	Dogs total
Low HCPI - Low analgesia	5	4	9
Low HCPI - High analgesia	0	0	0
High HCPI - Low analgesia	2	2	4
High HCPI - High analgesia	3	3	6

An ASI of the hind limbs was calculated for each chosen force plate and pressure sensing walkway system variable (PVF, VI, maximum rising slope, total pressure index, stance time and paw contact area) using the following equation: $(|X_R - X_L| / [|X_R + X_L| \times 0,5]) \times 100\%$. The ASI of PVF, VI, maximum rising slope, total pressure index, stance time and paw contact area from the baseline visit and the follow-up visit from both treatment groups were then compared to each other. Also the change in ASI values from the baseline visit to the follow-up visit for each variable and for both treatment groups were calculated. Normality of the data was tested by Kolmogorow and Shapiro-Wilk tests and none of the

ASI followed entirely normal distribution. The statistical significance of the results was therefore tested by using nonparametric tests. Values of $p < 0,05$ were considered statistically significant. The statistical analysis was done with the help of IBM SPSS Statistics – software (IBM SPSS Statistics for Windows, Version 21.0. Armonk, NY: IBM Corp.).

4 RESULTS

4.1 Clinical data

The total number of dogs for this study was 16: 8 dogs in the acupuncture group and 8 dogs in the placebo group. Initially there were 9 dogs in the placebo group and 10 dogs in the acupuncture group. These three dogs were excluded from the gait analysis because they were not able to perform valid trials either on the force plate or the pressure sensing walkway. In addition the force plate data of one dog in the placebo group was dropped out from the gait analysis because the dog in question did not have enough valid trials on force plate from the baseline visit. The acupuncture group was composed of 3 Labrador Retrievers, 2 German Shepherds, 2 Samoyed Dogs, and 1 Rottweiler. Placebo group consisted of 4 Labrador Retrievers and one of each of the following breeds: Flatcoated Retriever, German Shepherd, Lagotto Romagnolo and one cross-bred.

There were no statistically significant differences between the groups for sex, age, body weights or radiographic classification of hip joints (Table 5).

Table 5. Baseline characteristics of the acupuncture and placebo groups where the P-value signifies the difference between the two groups. P-value for the FCI classification of hips is the average calculated from the p-values of the left and right hip scores.

	ACUPUNCTURE GROUP	PLACEBO GROUP	p-value
male/female	2/ 6	3 / 5	0,589
mean age + SD, years	7,6 ± 3,78	6,9 ± 3,44	0,878
mean bodyweight + SD, kg	30,5 ± 5,03	33,8 ± 10,54	0,505
FCI classification of hips (number)	E/E (3), E/D (2), D/D (2), A/E (1)	E/E (2), E/D (1), D/D (4), A/D (1)	0,426

4.2 Asymmetry indices

All the six ASIs reduced from W_0 to W_3 in the acupuncture group. In the placebo group the ASIs of PVF and maximum rising slope reduced and ASIs of impulse, total pressure index, stance time and paw contact area increased. At baseline, the two groups were significantly different regarding ASI calculated from stance time ($p=0,028$) so that placebo group had smaller value than acupuncture group. This indicates that at baseline the placebo group had less asymmetry than the acupuncture group when comparing this variable between the groups. Otherwise comparisons did not reveal any statistically significant differences in the ASI values within and between the treatment groups. The mean ASI values, acceleration and velocity from baseline and follow-up visits from both treatment groups are shown in table 6. The table 6 also displays the changes in the mean ASI values from the baseline visit to the follow-up visit in the two groups. Figures 4-9 illustrate the alterations of the ASIs during the trial.

Table 6. Mean asymmetry indices and their changes from baseline visit to follow-up visit in the acupuncture and placebo groups. P-values within the groups represent the statistical difference between the visits while the last two p-values represent the differences between the groups at the times indicated. W_0 = the baseline, the first treatment visit and W_3 = follow-up visit.

	ACUPUNCTURE GROUP			PLACEBO GROUP			W_0	W_3 / change
	W_0	W_3	p-value within group	W_0	W_3	p-value within group	p-value between groups	p-value between groups
ASI, PVF + SD	12,28 ± 15,46	5,30 ± 3,25	0,263	8,28 ± 6,75	6,63 ± 5,45	0,735	0,867	1,000
Change W_0 to W_3 in ASI, PVF + SD	6,98 ± 14,98		-	1,65 ± 9,42		-	-	0,613
ASI, IMPULSE + SD	13,15 ± 16,15	7,57 ± 6,38	0,674	6,31 ± 6,47	8,16 ± 4,24	0,866	0,336	0,867
Change W_0 to W_3 in ASI, IMPULSE + SD	5,58 ± 17,84		-	-1,85 ± 6,98		-	-	0,463
ASI, MAXIMUM RISING SLOPE + SD	17,84 ± 19,44	12,05 ± 13,00	0,779	17,54 ± 14,30	13,48 ± 12,72	0,310	0,694	0,867
Change W_0 to W_3 in ASI, MAXIMUM RISING SLOPE + SD	5,79 ± 27,8		-	4,06 ± 16,04		-	-	0,955
ASI, TOTAL PRES INDEX + SD	18,61 ± 21,12	11,40 ± 6,47	0,575	11,69 ± 8,21	11,70 ± 7,70	1,000	0,721	0,878
Change W_0 to W_3 in ASI, TOTAL PRES INDEX + SD	7,21 ± 22,30		-	-0,01 ± 11,26		-	-	0,798
ASI, STANCE TIME + SD	8,28 ± 5,45	6,64 ± 5,07	0,398	2,71 ± 3,24	6,05 ± 7,36	0,116	**0,028**	0,574
Change W_0 to W_3 in ASI, STANCE TIME + SD	1,65 ± 5,88		-	-3,33 ± 7,13		-	-	0,161
ASI, PAW CONTACT AREA + SD	12,11 ± 10,15	10,10 ± 7,19	0,779	7,32 ± 9,25	13,73 ± 9,79	0,208	0,195	0,645
Change W_0 to W_3 in ASI, PAW CONTACT AREA + SD	2,01 ± 9,51		-	-6,42 ± 12,56		-	-	0,083
ACCELERATION+ SD, m/s^2	0,03 ± 0,18	0,09 ± 0,13	0,263	0,04 ± 0,10	0,06 ± 0,08	0,612	0,613	0,536
VELOCITY + SD, m/s	2,06 ± 0,19	2,06 ± 0,21	0,674	1,98 ± 0,21	2,00 ± 0,11	0,612	0,463	0,779

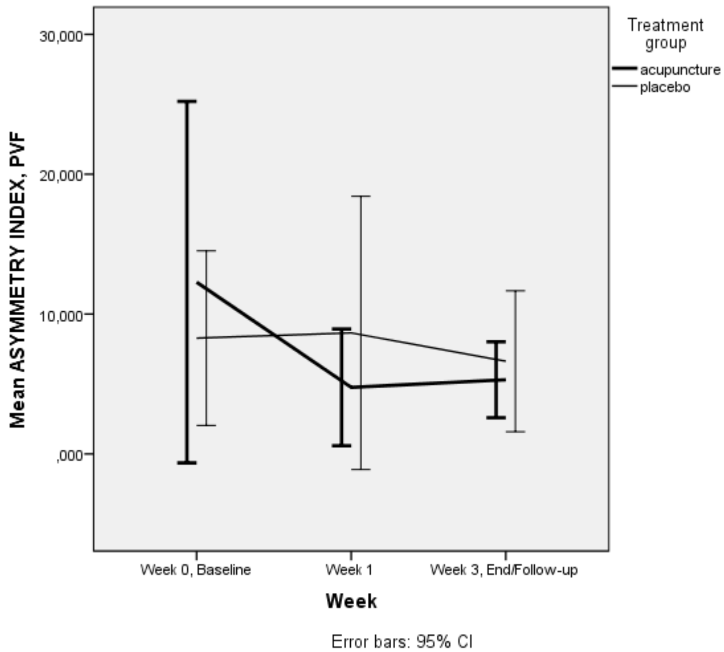

Figure 4. The range and mean values of asymmetry indices of PVF during the trial in both treatment groups

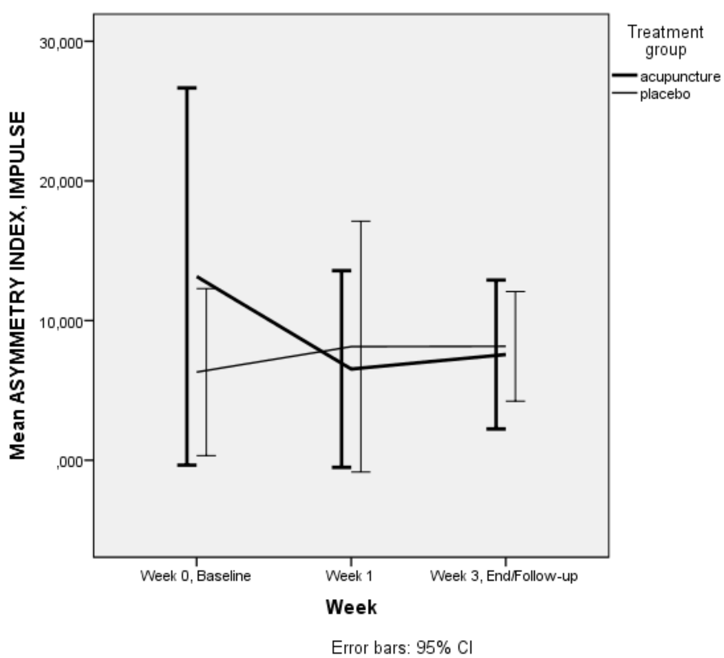

Figure 5. The range and mean values of asymmetry indices of impulse during the trial in both treatment group

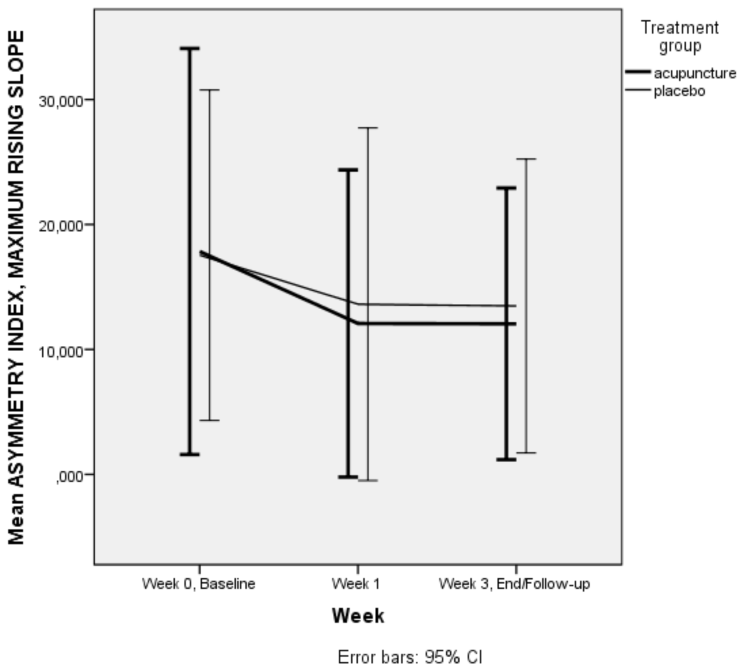

Figure 6. The range and mean values of asymmetry indices of maximum rising slope during the trial in both treatment groups

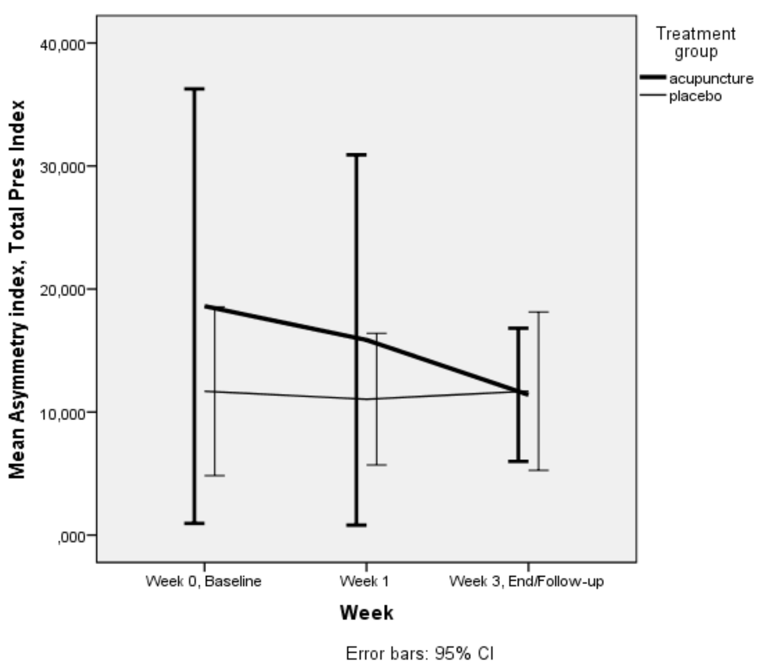

Figure 7. The range and mean values of asymmetry indices of total pressure index during the trial in both treatment groups

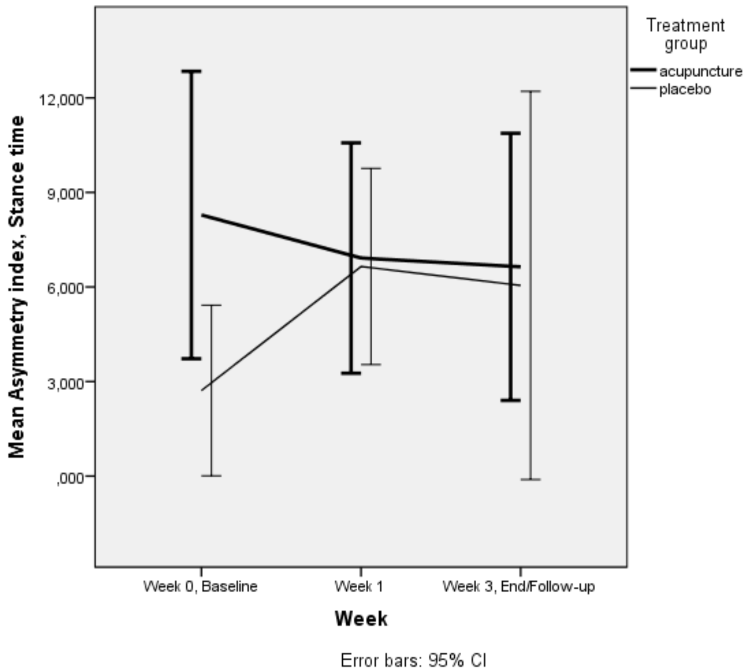

Figure 8. The range and mean values of asymmetry indices of stance time during the trial in both treatment groups

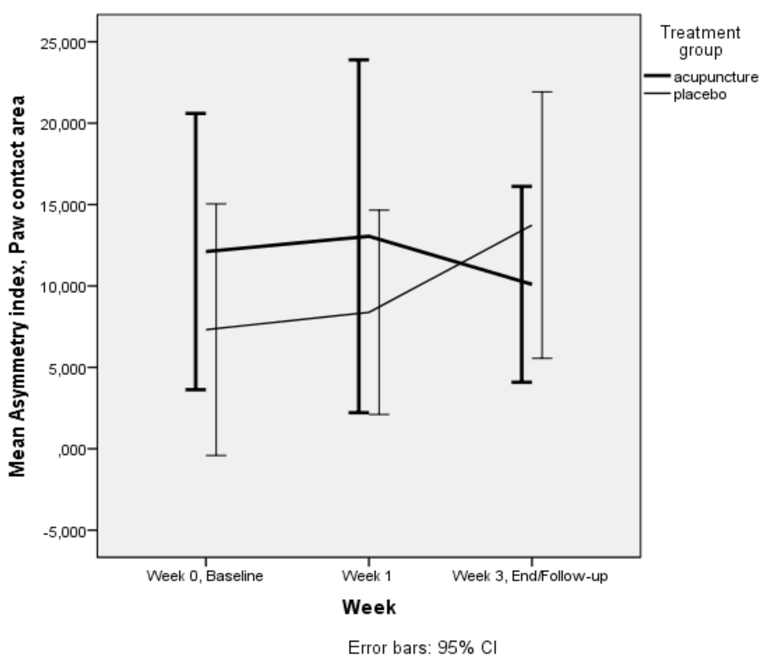

Figure 9. The range and mean values of asymmetry indices of paw contact area during the trial in both treatment groups

5 DISCUSSION

5.1 Results

In the present study trotting gait was selected as the study gait as it has been demonstrated to be more sensitive and accurate than walking gait in force plate analysis especially in differentiating normal dogs and dogs with low-grade hind limb lameness (Voss et al 2007). Emphasis was placed on trying not to affect ground reaction forces when performing gait analysis. This was done for example by keeping each dog's trotting velocity and acceleration constant by accepting only the passes that had the same range (±0,5 m/s) of velocity and acceleration from - 0.5 to + 0.5 m/s^2 each time the gait analysis was performed. Mean velocities in both treatment groups were approximately 2,0 m/s. The mean velocities and the acceleration variation correspond to many of the previous gait analysis studies (i.e. Allen et al. 1994, Bennett et al. 1996, Budsberg et al. 1996, 1999 a,b, Jevens et al. 1996).

The force plate was used in combination with the pressure sensing walkway. This multivariate approach was used to collect both kinetic and kinematic data simultaneously. In this study ASIs were calculated from the force plate for peak vertical force, vertical impulse and maximum rising slope and from the pressure sensing walkway for total pressure index, stance time and paw contact area. These multiple variables were chosen to gather data from both gait analysis systems and because it has been shown in many studies that using a combination of gait parameters yields better accuracy when assessing lameness than when using a single variable alone (i.e. Evans et al 2005, Fanchon and Grandjean 2007). From the variables chosen for this study peak vertical force, vertical impulse and maximal rising slope have also been stated as the most accurate ASIs for diagnosis of hind limb lameness in dogs in the study by Fanchon and Grandjean (2007). Also Oosterlinck et al. (2011) reported in their study that the sensitivity and specificity of ASIs for peak vertical force and impulse as well as paw contact area were excellent in discriminating lame and non-lame dogs.

A different range of asymmetry was detected in both treatment groups at the baseline visit. According to the cutoff values for ASIs in discriminating lame and non-lame dogs determined in previous studies (Budsberg et al. (1993) < 8 % for all kinetic variables, Fanchon & Grandjean (2010) < 3, 2 % for PVF, Oosterlinck et al. (2011) < 3-4 % for PVF and impulse) the dogs in both groups were lame at the baseline visit.

After dry needle acupuncture treatment asymmetry decreased for all variables in the acupuncture group while in the placebo group asymmetry increased for four variables and decreased for two variables. In the present study the reduction in ASIs from the baseline visit to the follow-up visit in the acupuncture group was greatest for the peak vertical force variable being -56,8 %. ASIs for impulse, maximal rising slope and paw contact area decreased 42,4 %, 32,5 % and 16,6 % respectively. Even though the ASIs decreased in the acupuncture group the asymmetry was still greater than what is found in normal, non-lame dogs determined in the studies by Fanchon & Grandjean (2010) or Oosterlinck et al. (2011). In the light of these two studies, this means that even though lameness may slightly have reduced, the dogs in the acupuncture group were still somewhat lame. However, it is evident that lameness does not disappear in such a short period because lameness continues to be present as long as there is inflammation in the joint. The dogs in the acupuncture group got acupuncture treatment only once a week for three consecutive weeks. With chronic pain multiple acupuncture treatments are usually required before a significant effect is produced (Gaynor 2000). In normal circumstances the acupuncture treatment would have been continued by doubling the treatment intervals (first by 2 weeks, then by 4, 8, 16 and 32 weeks) and finally staying on from two to three times a year for the rest of the lives of the dogs (Hielm-Björkman 2016, personal statement). Also if there are severe osteoarthritic changes in the joint the dog will probably limp more or less for the rest of its life, even though the pain decreases. This is due to restricted range of motion of the coxofemoral joints and possibly also due to learned way of moving (Fry and Clark 1992). In the placebo group the ASI for PVF and maximal rising slope had decreased 19,9 % and 23,1 % respectively. The ASI for total pressure index had basically stayed the same while the rest three ASIs had increased. Overall, it seems that in the placebo group asymmetry of locomotion had stayed nearly the same.

5.2 Limitations and bias

The major limitation of this study includes small sample size that causes low statistical power and a reduced chance of detecting a true effect.

There are also some factors that might have influenced the kinetic and kinematic data in this study. In the first instance, when velocity and acceleration constraints were taken into account, gathering enough successful passes was sometimes quite challenging. Because of this, there is often a large difference in the number of trials on the force plate between different dogs and even between different visits of the same dog. This “extra exercise” may have influenced the results by causing deterioration of limb function. Also, a low number of passes per visit per dog increases the possibility that a single, somehow abnormal pass is accepted. This can also affect the mean values of the chosen variables and falsify the dog’s results from that visit. Thirdly, different handlers and varying starting distances were used when passing the testing space. Different starting points were tried if there were difficulties in hitting the force plate correctly. It can be argued that the data would be more precise if we had used the same handler and the same starting distance during every pass.

In addition, one of our inclusion criteria for the study dogs was that they should not have any other major orthopaedic problems except hip dysplasia. However, we did not ensure this by taking radiographs from other joints than the hip but instead, our choice of suitable dogs was based on radiographs of the hips, an orthopaedic examination, a subjective evaluation of locomotion, and on owners’ observations, possible other radiographs and given history. At the same time, as there is evidence that several other joints than hips often are involved in hip dysplasia and as subjective evaluation has been shown to be a valid method at least for detecting severe lameness, it is very likely that the main problem our study dogs really had was hip dysplasia.

Finally, even though hip dysplasia is usually a bilateral disease, according to clinicians, nearly always one hind limb is worse than other. However, it is possible that lameness is symmetrical if the hind limbs are equally lame. In that case the asymmetry index can be normal which gives an impression of a sound dog. This limitation would have been counteracted in this study if values for separate hind limb gait parameters of each dog had been used to verify that the other hind limb really was worse than the other. In further analyses of this data one should also look at the changing of body weight from the hind limbs to the front limbs.

In conclusion, although no statistically significant changes were detected in our calculated asymmetry indices, the results indicate that dry needle acupuncture treatment might have had an influence on the locomotion of the dogs in the acupuncture group by slightly reducing hind limb lameness. Further research with a larger group of dogs and addressing also the other limitations of this study is still needed to test a possible significant effect of this method.

6 ACKNOWLEDGEMENTS

I would like to offer my special thanks to my main supervisor Anna Hielm-Björkman for her support and advice. I would also like to thank my second supervisor Cosmin Tuns, veterinarian Maritsa Palmunen and my fellow students Laura Rönkkä and Grim Wickholm for great teamwork during the clinical trial. Lastly, warm thanks also go to all the dog owners for their time and interest in this study.

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9 APPENDICES

Appendix 1.
FCI (Fédération Cynologique Internationale) scheme for grading canine hip dysplasia (Flückiger 2007)

A	**No signs of hip dysplasia:** The femoral head and the acetabulum are congruent. The craniolateral acetabular rim appears sharp and slightly rounded. The joint space is narrow and even. The Norberg angle is about 105°. In excellent hip joints the craniolateral rim encircles the femoral head somewhat more in caudolateral direction.
B	**Near normal hip joints:** The femoral head and the acetabulum are slightly incongruent and the Norberg angle is about 105° or the femoral head and the acetabulum are congruent and the Norberg angle is less than 105°.
C	**Mild hip dysplasia:** The femoral head and the acetabulum are incongruent, the Norberg angle is about 100° and/or there is slight flattening of the craniolateral acetabular rim. No more than slight signs of osteoarthrosis on the cranial, caudal, or dorsal acetabular edge or on the femoral head and neck may be present.
D	**Moderate hip dysplasia:** There is obvious incongruity between the femoral head and the acetabulum with subluxation. The Norberg angle is more than 90° (only as a reference). Flattening of the craniolateral rim and/or osteoarthrotic signs are present.
E	**Severe hip dysplasia:** Marked dysplastic changes of the hip joints, such as luxation or distinct subluxation are present. The Norberg angle is less than 90°. Obvious flattenting of the cranial acetabular edge, deformation of the femoral head (mushroom shaped, flattening) or other signs of osteoarthrosis are noted.

Appendix 2.
AKUPUNKTIOTUTKIMUSPOTILAAN SEURANTAKAAVAKE

Päiväys__________ Koiran nimi ______________________ Ikä ______ Sukup. ____________

Virallinen nimi _______________________________________ Rekkari ___________________

Omistajan nimi____

Kaavakkeen täyttäjän allekirjoitus____

Koiran pääoireet:____

Muistakaa että:

- Jokaiseen kysymykseen tulee laittaa yksi vastaus. (Ei enempää eikä vähempää.)
- Kysymyksiin tulee vastata joka kerta samalla lailla, eli arvioitte koiran vointia ajatellen aina samaa tilannetta. (Esim. jos olette aina vastanneet kysymyksiin arvioiden koiran vointia esim. pitkän lenkin jälkeen, tulee teidän jatkossakin verrata koiran vointia lenkin jälkeiseen tilanteeseen.)
- Jotta vastaukset ovat vertailukelpoisia, tulee saman henkilön vastata kysymyksiin joka kerta. Jos lomake on täytetty yhdessä, tulee se aina täyttää yhdessä.
- Merkatkaa ylös miten olette käyttäneet kipulääkkeitä sekä tähän lomakkeeseen että saamaanne kipulääkekalenteriin.
- Ilmoittakaa aina, jos koiranne vahingossa onkin saanut jotakin muuta hoitoa.

<u>Potilaan yleistila nyt</u>

Rastita yksi vaihtoehto / kysymys; se joka parhaiten vastaa koirasi tilaa **menneellä viikolla** (edellisen tutkimuskäynnin jälkeen).

1. Mielentila on:

erittäin virkeä	virkeä	ei virkeä, eikä apea	apea	erittäin apea
□	□	□	□	□

2. Koira heiluttaa häntäänsä:

hyvin usein	usein	silloin tällöin	harvoin	hyvin harvoin
☐	☐	☐	☐	☐

3. Koira leikkii:

hyvin mielellään	mielellään	vastahakoisesti	hyvin vastahakoisesti	ei ollenkaa	☐

4a. Koira kävelee:

hyvin mielellään	mielellään	vastahakoisesti	hyvin vastahakoisesti	ei ollenkaan
☐	☐	☐	☐	☐

4b. Koira kävelee:

erittäin helposti	helposti	kohtalaisesti	vaikeasti	hyvin vaikeasti
☐	☐	☐	☐	☐

5a. Koira ravaa (siirtää ristikkäistä etu- ja takajalkaa samanaikaisesti):

hyvin mielellään	mielellään	vastahakoisesti	hyvin vastahakoisesti	ei ollenkaan
☐	☐	☐	☐	☐

5b. Koira ravaa (siirtää ristikkäistä etu- ja takajalkaa samanaikaisesti):

erittäin helposti	helposti	kohtalaisesti	vaikeasti	hyvin vaikeasti
☐	☐	☐	☐	☐

6. Koira peitsaa (siirtää samanpuoleista etu- ja takajalkaa samanaikaisesti):

hyvin harvoin	harvoin	silloin tällöin	usein	hyvin usein
☐	☐	☐	☐	☐

7a. Koira laukkaa:

hyvin mielellään	mielellään	vastahakoisesti	hyvin vastahakoisesti	ei ollenkaan
☐	☐	☐	☐	☐

7b. Koira laukkaa:

erittäin helposti	helposti	kohtalaisesti	vaikeasti	hyvin vaikeasti
☐	☐	☐	☐	☐

8. Koiran tapa laukata muistuttaa takaa jänistä: molemmat takajalat liikkuvat yhdessä

hyvin harvoin	harvoin	silloin tällöin	usein	hyvin usein
☐	☐	☐	☐	☐

9. Koira liikkuu oma-aloitteisesti ulkona:

hyvin mielellään	mielellään	vastahakoisesti	hyvin vastahakoisesti	ei ollenkaan
☐	☐	☐	☐	☐

10. Koira liikkuu pidemmän levon jälkeen:

erittäin helposti	helposti	kohtalaisesti	vaikeasti	hyvin vaikeasti
☐	☐	☐	☐	☐

11a. Koira hyppää (esim. sohvaan, autoon tms.):

hyvin mielellään	mielellään	vastahakoisesti	hyvin vastahakoisesti	ei ollenkaan
☐	☐	☐	☐	☐

11b. Koira hyppää (esim. sohvaan, autoon tms.):

erittäin helposti	helposti	vaikeasti	erittäin vaikeasti	ei ollenkaan
☐	☐	☐	☐	☐

12. Koira kulkee rappusia ylös:

hyvin mielellään	mielellään	vastahakoisesti	hyvin vastahakoisesti	ei ollenkaan
☐	☐	☐	☐	☐

13. Koira kulkee rappusia alas:

hyvin mielellään	mielellään	vastahakoisesti	hyvin vastahakoisesti	ei ollenkaan
☐	☐	☐	☐	☐

14. Koira menee makuulle:

erittäin helposti	helposti	kohtalaisesti	vaikeasti	hyvin vaikeasti
☐	☐	☐	☐	☐

15. Koira nousee makuulta:

erittäin helposti	helposti	kohtalaisesti	vaikeasti	hyvin vaikeasti
☐	☐	☐	☐	☐

16. Koira läähättää kivun vuoksi:

ei juuri koskaan	harvoin	joskus	usein	hyvin usein
☐	☐	☐	☐	☐

17. Koira valittaa kipuja:

ei juuri koskaan	harvoin	joskus	usein	hyvin usein
☐	☐	☐	☐	☐

18. Koira valittaa kun takajalkoja venytetään taakse:

ei juuri koskaan	harvoin	joskus	usein	hyvin usein
☐	☐	☐	☐	☐

19. Koira liikkuu kovan rasituksen jälkeen:

erittäin helposti	helposti	kohtalaisesti	vaikeasti	hyvin vaikeasti
☐	☐	☐	☐	☐

Koiran liikuntavaikeudet

Arvioi koiran liikkumavaikeus piirtämällä rasti alla olevalle janalle, siihen missä se parhaiten kuvaa tämänhetkisen tilanteen:

Ei mitään vaikeuksia ____ Pahin mahdollinen tilanne

Koiran elämänlaatu

Arvioi koiran elämänlaatua piirtämällä rasti alla olevalle janalle, siihen missä se parhaiten kuvaa tämänhetkisen tilanteen:

Paras mahdollinen ____ Pahin mahdollinen

Kun täytitte yllä olevat kysymykset, millaista todellista kiputilaa arvioisitte että vastauksenne vastaavat:

- ☐ Vastaukset vastaavat tosi tilannetta, sillä koira ei ole syönyt kipulääkettä ollenkaan tai se syö niitä hyvin harvoin ja nytkin siitä on ainakin yli 3 vrk aikaa

- ☐ Vastaukset saattavat osoittaa että koiran tila ehkä on hieman parempi kuin se olisi ilman mitään kipulääkettä, sillä se on <u>ajoittain</u> saanut kipulääkitystä

- ☐ Vastaukset eivät välttämättä vastaa koiran todellista normaalia kiputilaa ollenkaan. Ne osoittavat todennäköisesti että koira on paremmassa kunnossa, sillä se on saanut kipulääkettä <u>useasti</u>

Onko koira saanut kipulääkettä edellisen tutkimuskäynnin jälkeen?

☐ Ei

☐ Kyllä, edellisen kerran_______ tuntia /vrk sitten

Kipulääkkeen nimi:_________________________________

Viime viikon kipulääkitykset:

Pvm ___: ______________ antokertaa
Pvm ___: ______________ antokertaa
Pvm ___: ______________ antokertaa

Pvm ___: _______________ antokertaa
Pvm ___: _______________ antokertaa
Pvm ___: _______________ antokertaa
Pvm ___: _______________ antokertaa

eli viikon aikana:

0 päivänä	1 päivänä	2-3 päivänä	4-5 päivänä	6-7 päivänä
☐	☐	☐	☐	☐

Muu kipuhoito edellisen viikon aikana:

Koiran muu lääkitys:

VERTAILEVA KYSELY

Seuravat kysymykset ovat vertailevia. Vertaatte koiranne nykytilaa siihen miten koira oli ennen toista tutkimuskäyntiä (eli ensimmäistä hoito-/lumekäyntiä):

Onko koiranne

	paljon parempi	vähän parempi	saman-lainen	vähän huonompi	paljon huonompi
Liikkuminen	☐	☐	☐	☐	☐
Rappusia ylös	☐	☐	☐	☐	☐
Rappusia alas	☐	☐	☐	☐	☐
Maaten alas	☐	☐	☐	☐	☐
Nousee ylös	☐	☐	☐	☐	☐
Ylöspäin kiipeily	☐	☐	☐	☐	☐
Hyppääminen	☐	☐	☐	☐	☐
Kävely	☐	☐	☐	☐	☐
Ravi	☐	☐	☐	☐	☐
Laukka	☐	☐	☐	☐	☐
Peitsaaminen	☐	☐	☐	☐	☐
Pupu-laukka	☐	☐	☐	☐	☐
Oma-aloitteinen liikkuminen	☐	☐	☐	☐	☐

<u>Tilanteita:</u>					
Levon jälkeen	☐	☐	☐	☐	☐
Kovan rasituksen jälkeen	☐	☐	☐	☐	☐
Rasitus + lepo, jälkeen	☐	☐	☐	☐	☐
Kipu - yleensä	☐	☐	☐	☐	☐
Kipu takajalkoja venyttäessä	☐	☐	☐	☐	☐
Läähättäminen	☐	☐	☐	☐	☐
Valittaminen kivusta	☐	☐	☐	☐	☐
Mielentila	☐	☐	☐	☐	☐
Sosiaalisuus	☐	☐	☐	☐	☐
Leikkisyys	☐	☐	☐	☐	☐
Elämänlaatu	☐	☐	☐	☐	☐
<u>Turkki ja iho</u>					
Turkin kiilto	☐	☐	☐	☐	☐
Turkin pehmeys	☐	☐	☐	☐	☐
Turkin tuuheus	☐	☐	☐	☐	☐
Ihon kunto	☐	☐	☐	☐	☐

Tällä kaavakkeella seurataan koirien yleistä hyvinvointia. Olkaa hyvä ja vastatkaa näihinkin kysymyksiin.

1. Ruokahalu on edellisen kuukauden aikana ollut:

erittäin hyvä	hyvä	tyydyttävä	huono	erittäin huono
☐	☐	☐	☐	☐

2. Koira on edellisen kuukauden aikana oksennellut:

0 kertaa / kk	1-2 kertaa / kk	1 x / viikko	3-5 x / viikko	melkein päivittäin
☐	☐	☐	☐	☐

3. Koira on edellisen kuukauden aikana ripuloinut:

0 kertaa / kk	1-2 kertaa / kk	1 x / viikko	3-5 x / viikko	melkein päivittäin
☐	☐	☐	☐	☐

4. Koiralle on edellisen kuukauden aikana noussut iho-oireita ja/tai kutinaa

0 kertaa / kk	1-2 kertaa / kk	1 x / viikko	3-5 x / viikko	melkein päivittäin
☐	☐	☐	☐	☐

5. Koira on edellisen kuukauden aikana saanut yleiskuntoon, niveliin tai lihaksiin vaikuttavia ravintolisiä

0 kertaa / kk	1-2 kertaa / kk	1 x / viikko	3-5 x / viikko	melkein päivittäin
☐	☐	☐	☐	☐

Mitä ja miten usein
____
____
____
____

Muuta kommenttia:
____
____
____
____
____

__**Hoitovaste**__

Hoitotulokseen olen tähän asti:

Erittäin tyytyväinen	Tyytyväinen	En osaa sanoa	Tyytymätön	Erittäin tyytymätön
☐	☐	☐	☐	☐

Hoitotulos on vastannut odotuksiani:

Täysin	Melko hyvin	Osittain	Melko vähän	Ei ollenkaan
☐	☐	☐	☐	☐

Luulen että koirani sai:

Akupunktiohoitoa	Lumehoitoa
☐	☐

Perustelut: (mitkä asiat ovat nyt paremmat tai huonommat)

____
____
____
____

____

Mitä tuotteita (ravintolisiä, lääkkeitä ym.) olette antaneet koirallenne ennen tutkimusta ja lakanneet antamasta tutkimuksen ajaksi?

____
____
____
____

Koetteko tarvitsevanne edellä mainittuja tuotteita enää?

□ Kyllä □ Ei

Oletteko toimineet koiranne kanssa jotenkin eri tavalla tutkimuksen aikana? (esim. liikunnan muutos, ruokinnan muutos/ koiran laihdutus, muutto…)

____
____
____
____

Onko koirallanne mielestänne □ alhainen kipukynnys
□ korkea kipukynnys

Onko teillä mielestänne □ alhainen kipukynnys
□ korkea kipukynnys

<u>Tutkimuspalaute:</u>

Jos teillä olisi toinen koira, jolla on samanlaisia oireita, kuin tutkimuksessa mukana olleella koiralla, osallistuisitteko uudelleen samanlaiseen tutkimukseen?

Hyvin todennäköisesti	Todennäköisesti	En osaa sanoa	Epätodennäköisesti	Hyvin epätodennäköisesti
□	□	□	□	□

Jos ystävällänne tai sukulaisellanne olisi koira, jolla on sama ongelma, suosittelisitteko akupunktiohoitoon osallistumista?

Hyvin todennäköisesti	Todennäköisesti	En osaa sanoa	Epätodennäköisesti	Hyvin epätodennäköisesti
□	□	□	□	□

Mitä hyvää ja huonoa tutkimuksessa ja sen järjestelyissä oli?

Muu palaute:

KIITOKSIA VAIVANNÄÖSTÄ!